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THE COMPREHENSION OF CONDITIONAL MESSAGES: A METHOD FOR INVESTIGATING THE VARIABLE MEANING OF 'IF'

by

STEVEN VAUGHN NICELY (C)

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Comprehension of Conditional Messages: A Method for Investigating the Variable Role of IF" submitted by Steven Vaughn Nicely in partial fulfilment of the requirements for the degree of Master of Arts.

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ABSTRACT

Two experiments investigated subjects' ability to construe implicit propositions as part of their comprehension of IF/THEN messages. Sucess depended on the presence of implicit propositions appropriate to one of the following 4 concepts of the Modality relations possible between two events: PHYSICAL CAUSATION, CONVENTIONAL SANCTION, MENTAL DECISION, and ANALYTIC ENTAILMENT. Subjects' performance in a sorting task or in a concept formation task revealed the validity of the 4 Modality concepts as descriptions of part of the cognitive meaning construable during comprehension of an IF/THEN message. A proposal is also presented regarding the semantic function of the conditional connective 'IF/THEN', in four of its common forms, following a critique of recommendations made by Wason & Johnson-Laird (1972).

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TABLE OF CONTENTS

CHAPTER	PAGE
INTRODUCTION	1
REVIEW OF LITERATURE ON THE COMPREHENSION OF CONDITIONAL SENTENCES	2
Selection Task	4
Evaluation Task	9
Conclusion 1	18
Propositional Reasoning and Logical Imperialism	19
Conclusion 2	26
The "Meaning" of Conditional Sentences	28
Implicit Propositions	33
STATEMENT OF THE PROBLEM	37
GENERAL METHOD	43
Materials	44
EXPERIMENT 1	47
Subjects	48
Procedure	49
Design	51
Results	53
Discussion	60
EXPERIMENT 2	62
Subjects	63
Procedure	64

Design 66

Results 68

Discussion and Conclusion 75

BIBLIOGRAPHY 87

APPENDIX A 91

APPENDIX B 93

APPENDIX C 95

LIST OF TABLES

Table	Description	Page
1	Treatment means from Experiment 1 for the four Message types (pcma) and the four Target concepts (PCMA)	55
2	(a) Comparisons on means from Table 1 (b) Difficulty orderings derived from Table 2a	55
3	Proportions and (Totals) of correct and error YES replies in the 16 response categories of Experiment 1	57
4	Indices of individual success in Experiment 2	69
5	Totals and means of YES replies in Experiment 2	73

INTRODUCTION

The research reported here investigates the comprehension of conditional messages. In two studies, subjects' successful completion of a task is dependent on "appropriate" comprehension of unstated relations between the antecedent and consequent events described in IF/THEN messages. Previous research can be interpreted as showing that persons' understanding of sentences having the form "If A, then C." is highly variable, and that they expect the antecedent and consequent to be meaningfully related. Appropriate understanding of such sentences appears to require an implicit understanding of propositions about the contextually plausible relations that could obtain between the two propositions (or events). The word 'if' and the sequential connection of the clauses may invite or tempt the hearer to do this. These implicit propositions, which bear on the relations between antecedent and consequent are not expressed by either of these two clauses, nor, presumably, by the standard meaning of 'if'.

In beginning to investigate a hearer's construal of implicit relations between propositions, we enter the domain of the interpretation of connected sentences--discourse and

texts. When comprehending texts we seem to be able to "read between the lines", to weave a coherent fabric of interpretation around a sequence of sentences or clauses. IF/THEN sentences may well be an illuminating instance in which beliefs about extra-linguistic matters enable the hearer to construe plausible relations between propositions. If so, results on the comprehension of IF/THEN messages, while uncovering the psychological meaning of the IF/THEN connective, will also have implications for theories of comprehension. Such theories as there are focus almost entirely on the interpretation of sentences isolated from discourse or texts.

REVIEW OF LITERATURE ON THE COMPREHENSION OF CONDITIONAL SENTENCES

Investigation of the comprehension of conditional sentences is sparse. Most of the research is concerned with logical reasoning. Reasoning research in the British tradition has investigated comprehension in the sense that the subject's understanding of IF/THEN and related sentences has been assumed to consist most importantly in his interpretation of the truth conditions of the sentence. The truth table for material implication in propositional calculus is put forth as the normative standard for the truth conditions of English IF/THEN sentences. Obviously,

this assumption constitutes defining English IF/THEN as truth-functional. A truth-functional connective is one in which the truth-value (either TRUTH or FALSITY) of a compound expression is a function only of the truth-values of the component expressions, for each possible combination of truth-values of the component expressions. The meaning of a truth-functional connective is exhausted by its truth-table. A prime target in my criticism of the research reviewed below will be the premise that the meaning of English IF/THEN is to be characterized primarily by the function which defines its truth conditions. An alternative characterization will be formulated and this will provide the basis of the research to be proposed below.

One result of research on propositional reasoning with adults has been the repeated "rediscovery" that people do not behave as if they were truth tables. In light of this finding, the focal problem of the research has been to discover the conditions under which subjects do or do not behave in conformity to the normative standard. Much of the research has attempted to rehabilitate subjects' reasoning in the direction of the logical standard, using versions of the "selection" task and the "evaluation" task.

Selection Task

The typical selection task consists of giving the subject a rule, such as "If there is a D on one side [of a card], then there is a 7 on the other side", together with 4 cards showing D,K,7,3, respectively, on the visible side. The task is to select just the cards which need to be turned over in order to decide if the experimenter is lying (that is, whether the rule is true or false). The logically correct choice, given that the above rule of "If D, then 7" is represented logically as "If p, then q", is the cards showing p and not-q, which in this case are the cards showing D and 3. The most common choices are that of p alone or of p and q. In an effort to lead subjects to logical "insight" into the task (Johnson-Laird & Wason, 1970a), subjects have been offered explanations of the task before getting a second try, allowed to view the stimulus materials in advance to discover the alternatives, corrected on their guesses as to what they expect to falsify or verify the rule, and others. (See Wason & Johnson-laird, 1972, for a review of some of these attempts).

As an indication of the success of these efforts, the relevant results from the following reports were tabulated: Wason (1968, 1969), Johnson-Laird & Wason (1970), Wason & Johnson-Laird (1970), Legrenzi (1970), Goodwin & Wason (1971), Lunzer, Harrison & Davey (1974),

Gilhooley & Falconer (1974), and Bracewell & Hidi (1974). The distribution into the choice categories of (p,q) (p) (p,q,not-q) (p,not-q) and (other) is 147, 138, 37, 58, 94. In other words 12% make the logically correct selection of (p,not-q). Sharp improvements, however, have been induced by the use of more natural or intelligible conditional sentences. Three studies, Wason & Shapiro (1971), Johnson-Laird, Legrenzi, & Legrenzi (1972), and Bracewell & Hidi (1974), obtained the following percentages of correct selections for thematic sentences versus abstract sentences: 60% vs. 10%; 85% vs. 10%; and 75% vs. 14%. One such thematic sentence was "Every time I go to Manchester, I travel by car." Subjects were allowed to study the stimulus materials prior to doing the task.

It would seem that the manifest difficulty of the task using abstract sentences should either be intrinsic to the task, due to the nature of the procedure and the stimulus materials, or extrinsic to the task itself, resulting from a disparity betweeen the E's and the subject's interpretation of the sentence rule. The E abstracts a logical form for the sentence and interprets it according to the logical meaning of the logical connective. Naive regarding the calculi of propositional and predicate logic, the subject presumably does something different in coming to an interpretation of the sentence. If the subject's interpretation of the sentence does not consist in

a truth table at all, much less one identical to that adopted by the E, then it is unlikely that the subject is even performing the same task as that anticipated by the E.

Ambiguity as a result of either one or both of the above factors is strongly implicated by the following rather startling facts. In order for the subject to perform in accord with the experimenters logical demands, it is not necessary that the subject understand conditional sentences as having the truth table of material implication (ie., TFTT, for the cases (p,q),(p,notq), (not-p,q) and (not-p,not-q)). In fact, any truth table which specifies FALSE for the case of (pnot-q) is logically adequate to enable the subject to select the logically correct cards, if only the subject possesses one of these tables as his understanding of the truth conditions of sentences like the sentence rule which he is attempting to verify or falsify. Furthermore, any belief on the part of the subject, to the effect that the sentence rule is falsified by any occurrence of case (p,not-q), is sufficient to meet the E's logical demands. The only plausible conclusion that I can draw in light of these circumstances is that either the stimulus cards are ambiguous or the subject's understanding of the conditional sentence rule, whatever it may in fact consist in, does not include in it a table of truth values for all possible truth values of the component sentences. The abstract sentence rule appears to introduce its own peculiar

source of ambiguity.

Results reviewed by Wason & Johnson-Laird (1972, Ch.13) demonstrated that numerous modifications of the stimulus cards and of the procedure have failed to ameliorate the difficulty of the task . The finger of evidence points to the conclusion that subjects do not have in their minds one or more truth tables with which they "understand" IF/THEN sentences and which they consult when called upon to solve logical tasks. The high success of subjects on the thematic version of the task does not then appear to be due to an otherwise unmanifested ability to retrieve an appropriate truth table and consult it.

The conclusion that subjects' understanding of IF/THEN is not constituted by some truth table or other is the very conclusion that is resisted by Wason and Johnson-Laird, for it goes against the whole tenor of their research. They have continuously presupposed the empirical hypothesis that understanding is to be specified by a truth table, for IF/THEN, in English, is taken to be a logical connective. Originally, IF/THEN was assumed identical in meaning to the material implication sign ' '. More recently their faith in the propositional calculus has been shattered (1972, p.92).

> It is evident that a conditional may possess the logic of material implication, material

> equivalence, or the 'defective' truth-table. It is not a creature of constant hue, but chameleon-like, takes on the colour of its surroundings: its meaning is determined to some extent by the very propositions it connects. This property yields a final argument against the propositional calculus as a model of the deductive component.... it is clear that conditionals must be cohesive precisely because they are not merely used to convey truth-functional relations between their components. They are, in fact, used to establish particular semantic relations, such as causal connection or logical implication, and it is from these relations that their truth-functional properties arise.

In this and nearby passages, Wason and Johnson-Laird affirm that the IF/THEN, or conditional connective changes its meaning (ie., truth conditions) depending on certain non-logical aspects of the particular propositions so connected. Moreover, they now affirm that sentences containing this connective are "used to establish particular semantic relations." Despite this avowal, however, the variation in understood meaning of the connective, in English discourse, is claimed to be a variation in the truth table which is allegedly associated to it by the hearer. Thus the earlier assumption, that the meaning of IF/THEN in English should be expressed by the truth table for a logical

connective, has not been altered. In their Information Processing model for explaining performance on the selection task (1972, Ch.14), these authors argue that the truth table which a subject associates to the connective must be discovered before the model can be applied. The first stage of the model is "Examine rule. Retrieve 'truth table'." They recommend the "evaluation" task, to be discussed now, as a method for discovering the meaning of the connective for a particular subject. A look at the evaluation task will lead us into the analysis which Wason and Johnson-Laird propose for the most typical everyday meaning of the conditional connective.

Evaluation Task

Like the selection task, the evaluation task has been a source of the evidence which prompted the dissolusionment of Wason and Johnson-Laird with the propositional calculus as a model of everyday thinking. In contrast with the selection task, subjects in this task evaluate the truth value of a sentence rule against 4 cards each of which allow the subject to see all the relevant truth value information for one of the four cases. A revealing study employing this task is one entitled "How Implication Is Understood" (Johnson-Laird & Taggart, 1969). What is to be "understood" by the subjects in this study is not in fact material implication, but four English sentences, each alleged by the

authors to be translations into English of the logical form p q. Though the subjects are logically naive, the intent appears to be to discover which English expression best expresses material implication to them.

The four sentences are these:

(1) If there is an A on the left, then there is a 7 on the right.

(2) There isn't an A on the left, if there isn't a 7 on the right.

(3) Either there isn't an A on the left, or there is a 7 on the right.

(4) There is never an A on the left, without there being a 7 on the right.

In all four conditions subjects were presented cards showing A7, A8, B7, and B8. The predominant pattern of reply (39 of 96) was to treat the first two cards as verifying and falsifying, respectively, while considering the cards with B's to be irrelevant. This yields the "defective" truth table of (TF??) for the conditions (p,q), (p,not-q), (not-p,q) and (not-p,not-q). This table was predominant for sentences (1), (2) and (4) at the rates of 19 of 24, 5 of 24, and 14 of 24. For (3) the largest category of reply (8 of 24) was the correct one of TFTT. Among the 57 trials on which the defective truth table was not found, there were 27 different patterns of reply.

This study was originally interpreted as confirming that implication (ie., material implication) is not understood in a logically correct manner. The predominance of truth table (TF??) is, however, compatible with the performance of subjects who performed adequately on the selection task when "thematic" IF/THEN sentences were used. The same study is also interpreted (in Wason & Johnson-Laird, 1972, Ch.8) as demonstrating that IF/THEN, the primary connective used in forming conditional sentences, most typically has the meaning captured by the defective truth table. Both of these interpretations are faulty, for the following reasons.

(1) The original interpretation held that implication was not understood according to logical standards, but in various other ways, indicated by the several truth tables obtained in the study. Material implication, however, is a logical relation whose meaning is exhausted by its truth table. Once one learns the truth table associated with ' ' , one "understands" material implication. Now the subjects in the study were logically naive, so they had not yet learned the meaning of the material implication sign in propositional logic. Moreover, this sign did not occur in any of the four English sentences. Therefore, the sentences presented to the subjects were not material implication sentences, nor could they be so construed by persons who did

not know propositional logic. The question of logical correctnes, thus, cannot arise. The question which can arise, and which is not a matter of logic, is whether certain English sentences have the same truth conditions as some logical connective.

(2) The second interpretation is that the study supports the analysis of IF/THEN as meaning or having the truth conditions expressed by the defective truth table. Before considering the defective truth table itself, let us look first at the thesis that the evaluation task is a procedure by which the meaning which subjects associate with a connective may be discovered. The results of the evaluation study are taken to support an answer to a question which is similar to the kind of question which we claimed can legitimately arise—what is the typical meaning of the IF/THEN connective in English? But this question differs importantly from the kind of question which we allowed. It is about a connective rather than about one or more sentences containing that connective. If an answer as to the meaning of a connective is intended to also give the answer or provide the conclusion as to the truth conditions of most sentences which contain that connective (eg., most conditional sentences), then what requirement must be met? The truth conditions of most of the sentences which contain that connective must be exhausted by the meaning of the the connective. Wason and Johnson-Laird simply take for granted

that this requirement is met, for they assume that the meaning of the conditional connective (despite that its meaning may vary, as quoted above) exhausts the logical interpretation or truth conditions of most conditional sentences. Supposing this to be the case, does the above study show that the most typical meaning which subjects associate to the IF/THEN connective is captured or expressed in the defective truth table?

Emphatically not! For the strategy of inference is a fallacious one. The inference moves from the data on subjects' judgments about truth and falsity of sentences to a conclusion about the structure of the meaning which subjects associate with the connective in the sentences. The structure is alleged to be "revealed" by the structure of the scheme (truth table) into which the judgments were classified. This truth table is purported to be structurally isomorphic to the mental state which enables the subject to manifest the judgments which he did. But any other mental state, though differing in structure (whatever structure is), is functionally equivalent to this mental state so long as it disposes the individual to behave equivalently (make the same truth value judgments) when asked to give judgments of truth-values. To assume that the newly evidenced mental state, since it did enable the behaviors to occur, is structurely isomorphic with the scheme for classifying the behaviors is ludicrous. And

remember that the very possibility for making this fallacious inference depended on the authors' assuming that subjects make judgments about the truth or falsity of an IF/THEN sentence based only on how they interpret the connectives contained in the sentence.

This assumption is a special instance of a premise which pervades the reasoning research in the tradition we are discussing. The general premise will be discussed later . I conclude that, whatever the virtues of the particular study and of the evaluation task, the above interpretations are in error. The evaluation task cannot reveal to one that the interpretation which a subject gives to IF/THEN is isomorphic to some truth table or other. It merely shows whether the judgments about truth values are compatible with the judgments a logician would make, were the sentence in question to be appropriately translated into a logical expression whose primary connective had that truth table.

I have argued that evidence obtained with the evaluation task is incapable of supporting an inference to a conclusion that some truth table or other constitutes the meaning which a person associates with an English connective. As stated, the argument does not exclude the possibility that a person's understanding of IF/THEN might in fact be the <u>defective</u> truth table, for example. Without marshaling explicit arguments, I have also cast disparaging

remarks toward Wason's and Johnson-Laird's assumption that the truth conditions (or interpretation or meaning as they use these terms) of a conditional sentence (for a person on a particular occasion) is exhausted by the truth table which the person allegedly associates with IF/THEN. But let us temporarily suppose this assumption to be valid, and look at the theory which the authors propose for the most typical meaning of the conditional connective IF/THEN. The statement which is discussed in the following quote (1972, p.90) is "If John loved Mary, then he married her."

> The determination of the presuppositions of a statement is an intricate task of linguistic analysis. But, in the case of the conditional the task is much simpler: the antecedent is an explicit statement of a presupposition. Hence, as Quine (1952) remarked, the ordinary conditional is a conditional assertion rather than the assertion of a conditional. When the presupposition stated by its antecedent turns out to be unfulfilled, no assertion is made: it is not treated as true and it is not treated as false. It is irrelevant. When it transpires that John did not love Mary, the statement about his marriage to her is empty: it is as though it had never been made. On this presuppositional analysis, the conditional has an incomplete or 'defective' truth-table: no value is specified for those cases where the antecedent is

> false: ....It was our conviction that this interpretation of the conditional provides its commonest employment in ordinary usage; and we set out to test this hypothesis in an experiment (Johnson-Laird and Tagart, 1969) (emphasis added).

As we saw above, 19 of 24 subjects in the experiment were consistent with the defective truth table in their classification of cards, when an IF/THEN sentence was presented.

There are two arguments which, if sound, show their analysis to be untenable. (i) The defective truth table would produce absurdities in reasoning. Consider the correct arguments that the defective truth table would authorize. An English statement of the form 'If p, then q' would be true only when p and q are jointly true, and would be false when p is true and q false. For the two cases when p is false the complex statement would be VOID, according to Wason and Johnson-Laird. Thus the statement "If p, then q" entails the statement "p and q". Because of this entailment, the following arguments are "logically" correct, so to speak:

CASE 1 If John loved Mary, then he married her.
He did not marry her.
THEREFORE: He married her and he did not marry her.

CASE 2: If John loved Mary, then he married her.

John did not love Mary.

THEREFORE: John loved Mary and John did not love Mary.

In both cases an explicit contradiction is reached. If most persons understand ordinary IF/THEN statements as having the truth conditions which are expressed in the defective truth table, one should find that most people would reason in the above ways with most IF/THEN statements.

(ii) The defective truth table excludes all occurrences of the major kinds of IF/THEN statements. If the statement "If p, then q" is true only when "p and q" is true, then IF/THEN statements of the following kinds are either FALSE or IRRELEVANT:

those in which reference is made to some (perhaps unspecified) future time, as in "If it rains, then the match will be cancelled"; those which, as in all of the sciences and arts, express any kind of regularity or dependency; those which are used in hypothetical or suppositional reasoning, where the antecedent is either false or contradicts current beliefs or has an unknown truth value; any others to which the question of truth or falsity is not appropriate, as when the statement may take on probabilities less than one. In light of the above two points, one should

be very suspicious of any empirical evidence alleged to support Wason and Johnson-Laird's claim that "this interpretation provides its commonest employment in ordinary usage."

Conclusion 1

The conclusions which I have put forth regarding results from the selection task and the evaluation task are summarized here as follows. (a) The disparity which has been found between results with abstract sentences and results with thematic or coherent sentences suggested the following resolution. The inexplicable difficulty occasioned by the abstract sentences implicated an incongruence between the experimenter's interpretation of the sentences (which provided the logical standard for the subject's performance) and the subject's logically naive attempt to understand what the sentence was saying. The task with an abstract sentence was conjectured to be ambiguous, due most likely to the sentence's not being readily interpretable as some kind of conditional sentence. Subjects responded adequately when presented with a thematic sentence, in which the antecedent and consequent were "meaningfully" related. Some additional factors must have facilitated appropriate truth table judgments for the abstract sentences. These factors are more likely to depend on the sentence's "making sense" as a conditional, rather

than on the subject's recovering his ability to retrieve and consult a stored truth table.

(b) The evaluation task has been convicted of being totally impotent for the task of "revealing" the truth table which is assumed by Wason and Johnson-Laird to constitute a person's interpretation of an English connective. Furthermore, their proposal that the alleged truth table of the conditional connective is most commonly the defective truth table was found to be conceptually untenable on two grounds.

Propositional Reasoning and Logical Imperialism

Subjects' understanding of IF/THEN sentences has also been investigated in research on reasoning from premises which include a conditional statement (eg. Taplin, 1971; Taplin, Staudenmayer & Tadonio, 1974; Roberge, 1974; Leahy & Wagman, 1974). These investigations are a recent trend in the same tradition of thinking as was the research discussed above. The stimuli have typically been meaningless existential sentences, such as "If there is a Q, then there is an R" or "There is a Q", which appear in arguments of the following four forms:

If p, then q.

p — Affirming the Antecedent: Modus Ponens

THEREFORE: q

If p, then q.

not-q

THEREFORE: not-p

Denying the Consequent: Modus Tollens

IF p, then q.

not-p

THEREFORE: not-q

Denying the Antecedent: Fallacy

If p, then q.

q

THEREFORE: p

Affirming the Consequent: Fallacy

These studies reveal that the members of every age category from Grade 3 through graduate students in educational psychology (i) exhibit the truth table for the material biconditional (TFFT) when reasoning with IF/THEN sentences; (ii) largely fail to affirm the validity of arguments having the form of Modus Tollens; and (iii) affirm the validity of logically fallacious inferences involving Denying the Antecedent and Affirming the Consequent. What does it mean for an investigator to have discovered that subjects most commonly treat the conditional as a biconditional and consistently affirm the validity of logically fallacious arguments? I argue that drawing such conclusions about their subjects' comprehension and reasoning is simply irresponsible, for several reasons.

(1) The arguments employed earlier against interpretations of the selection and evaluation tasks apply here as well. Thus, for instance, subjects can not be accused of treating material implication sentences as material biconditional sentences, for there were no material implication sentences present, in the eyes of the subjects. And if they really did interpret the stimulus sentences as having the truth table of the material biconditional, then the predominant patterns of reasoning can not be called fallacious. Affirming the Consequent and Denying the Antecedent are <u>logically correct</u> when reasoning from a biconditional statement.

(2) There are many circumstances under which one should be able to classify subjects' judgments under the biconditional truth table (TFFT). Exhibiting the table (TFFT) does not mean that subjects understand the connective IF/THEN by associating to it the biconditional truth table. In addition to the arguments given above when discussing the defective truth table, there are still other telling reasons for avoiding such an unwarranted interpretation. The table (TFFT) should be appropriate to the data of a reasoning task whenever subjects interpret the antecedents of the IF/THEN statements to either be necessary for the truth of the consequent, as in "If the atomic weight is 79, then it is gold," or be exclusively sufficient for the truth of the consequent, as when an event has a single unique cause. An

example of the latter occured in an experiment by Legrenzi (1970) in which a light was ON only when a switch was in ON position. The table (TFFT) was manifested. The biconditional table should also be exhibited whenever subjects produce conclusions which are only plausible and do so by affirming the consequent and denying the antecedent. Thus the Experimenter's detecting the table (TFFT) can be a consequence of subjects being inclined to reason to plausible but not logically necessary conclusions.

(3) If subjects are logically naive, then they are unlikely to have been trained to distinguish logically necessary from factually plausible inferences. Moreover, behaving logically in the above reasoning tasks requires that the IF/THEN statements be abstracted as equivalent to "p q" or "p logically entails q". Logically naive subjects could not be expected to treat IF/THEN as having the truth table of (TFTT), which is what is required before their reasoning can match the a priori demands of the experimenter. Questions of logical fallaciousness are appropriate only when the relation of premises to conclusion is claimed to be that of logical necessity--what must be true given that the premises are true. When subjects are actually concerned to produce the conclusion which seems to be the most plausible or most probable, given the premises, it is misleading for one to characterize their inferences as being fallacious. Furthermore, if the IF/THEN statement is

not, or cannot be assumed to be, appropriately abstracted by the relations of material or of logical implication, then the argument forms used for the stimulus sentences only appear superficially like those of Affirming or Denying the Antecedent or Consequent.

When the circumstances which a subject faces in an experimental situation are similar to those noted just above in (2) and (3), his task is an ambiguous and unsolvable one. Labile sentence interpretations should be expected under these conditions, for the interpretation which a subject attempts to make may seem awkward and inappropriate, in addition to being counter to the experimenter's predelictions. For example, Paris (1973) found that 5th-graders through college students treated "IF" and "IF and only IF" as being equivalent when verifying sentences against pictures showing pairs of events such as "The boy is riding the bicycle—The shoe is on the foot". He reported that all subjects beyond the second grade were looking for causal relations between the events. Apparently they seldom found causal relations under these circumstances. Yet, as we argued above, interpreting IF/THEN causally may be responsible for subjects attempting to make factually plausible inferences which are analogous in form to logically fallacious inferences. This alone will result in subjects exhibiting the table (TFFT). An experimental demonstration has been provided by Evans (1972) of the

influence of preferrred interpretations of a connective on the patterns of reasoning which subjects exhibit (and, hence, the truth table which they manifest). Evans argues that certain syntactic forms are understood as having preferred or typical semantic functions depending on the context in which they are used. He found that inferences by Modus Tollens were favored over inferences by Modus Ponens when the conditional had the form 'p only if q'. The opposite preference occurred when the conditional had the form 'If p, then q'. Moreover, when there is some kind of empirical relation implicated between the antecedent and consequent, the two types of conditionals diverge even more. When the sentence "If I work hard, then I shall pass my exam" is transformed into "I work hard, only if I shall pass my exam", the meaning of the first sentence is drastically altered. Evans uses evidence such as this to attack the research tradition which we have been criticizing all along. He argues that the tactic of construing subjects' performance as either conforming to or deviating from logical correctness has resulted in the misrepresentation of resoning data and a lack of psychologically plausible attempts at explanation.

Throughout our discussion thus far, we have run into numerous instances which support Evan's evaluation. At numerous points above, I have discussed an important assumption which, in each case, manifests a distinctive and

pervading attitude toward subjects' reasoning--this attitude I will call "Logical Imperialism". The fundamental tenet of Logical Imperialism is this. "What is logical in the eyes of the Experimenter bloody well should be good enough for the subject." Inotherwords, the Experimenter's logical judgments are <u>prescriptive</u> for the subject's logically naive reasoning, and are held to be in fact <u>descriptive</u> of his reasoning, unless the weight of evidence speaks loudly to the contrary.

> The nexus of assumptions through which the attitude of Logical Imperialism is protracted upon the subjects' reasoning, includes the following.
>
> (a) The meaning of an English connective consists in a logical truth table stored by the subject and associated by him to the connective.
>
> (b) The truth conditions of an English conditional sentence are in fact exhausted by the truth conditions of the connective which it contains.
>
> (c) A subject's reasoning and his judgments about truth values are based upon his consulting a stored truth table.
>
> (d) The translation of English sentences into appropriate logical form is a straightforward matter which is governed by accepted logical rules.

Conclusion 2

The research produced and interpreted under the above presuppositions is to be faulted precisely because all of the propositions are false. I will not further discuss these assumptions exept to note the following. Wason and Johnson-Laird reject standard propositional logic as a description of the psychological processes of everyday reasoning. (This would be an attack on a straw man were it not for the fact that they are attacking their own earlier views.) Standard propositional logic is rejected for being binary truth-valued and truth-functional (Wason & Johnson-Laird, 1972, p.92). However, they concurrently affirm the principle of truth-functionality with their holding of assumptions (a), (b) and (d). They do acknowledge that the truth table which a subject allegedly associates to the conditional connective may vary, depending on the particular propositions which it connects. Yet regardless of which truth table is used or is appropriate, they still assume that the truth value of a conditional statement is to be a function only of the truth values of the two component propositions.

With this set of assumptions, Wason, Johnson-Laird, and others are trapped in a circular pattern of reasoning about their research, which pattern is characteristic of Logical Imperialism: Inappropriate logical standards are

superimposed upon the subject's reasoning task. Then the data are interpreted as deviating or conforming to these standards. Propositions are proffered to explain the unexpected or non-intuitive results which have been discovered. These explanations deal with the presence and absence, in the subjects, of logical abilities. The hypothetical abilities are patterned after logical concepts such as truth tables, rules of inference, the principle of truth-functionality, axioms, etc. Since a subject's behavior is described using concepts from logic, the virtually inescapable circle requires that the explanation of the behavior should hypothesize psychological analogies of the logical concepts: truth tables, rules of inference, truth-functionality, axioms, etc. Within this circle, a continuous flow of unexpected results and inappropriate explanations is almost guaranteed.

A fitting contrast to the myriad studies showing children and adults to be logically deviant reasoners, is a study by Brainerd (1970). He found elementary children to reason in conformity to "logical" dictates when required to make inferences about the transitivity of causal relations. They were read pairs of sentences, designed especially for children, of the form "p regularly causes q. q regularly causes r." The children were able to correctly answer questions about what was necessary or possible when certain of the three events did not occur.

The "Meaning" of Conditional Sentences

The preceeding evaluation may serve as the take-off point for many topical questions regarding people's comprehension of IF/THEN sentences. However, the reasoning research in the Logical Imperialist tradition has provided no positive guides toward answers to such questions. Rather, the research merely reinforces what has long been held true--that people do not treat conditional sentences as being appropriately used or as making sense unless the antecedent and consequent propositions can be seen as "meaningfully related." The so-called abstract conditional sentences left subjects searching for relations between the component propositions, and interfered with their preferred patterns of reasoning about truth and about warranted inference. I do not, however, presume to be prepared to answer questions about HOW in fact subjects reason. I think such questions are yet a considerable way from even being appropriately asked.

An important prolegomenon to questions of HOW is that of the discovery of the variables which affect persons' understanding of IF/THEN sentences and of the semantic components of their understanding. Some questions which are germane in light of the above evaluation of reasoning research are the following.

(1) If a subject's judgments about the truth values of IF/THEN sentences, and his logical reasoning with such sentences, are not based upon his consulting a truth table, then on what are they based? Presently, it seems most plausible, and almost trivially so, to hold that such decisions depend largely on what the sentence is understood, at a particular moment, to be stating—ie., its truth conditions as then interpreted by the subject.

(2) If the considerations which are relevant to a person's interpretation of the truth conditions of an IF/THEN sentence are not exhausted by the meaning which he associates to the connective in isolation, then what are the further factors on which his understanding of truth conditions depends? The emphasis which has thus far been placed upon conditions of TRUTH must be liberalized to include matters of probability, correctness, and/or appropriateness. One factor which should be noted here is that attributed earlier to Evans (1972). Different morphological forms of the conditional connective may have a preferred or typical semantic function, which function contributes to the person's interpretation of the conditional sentence.

(3) If a person's understanding of the IF/THEN connective, independent of its form, does not consist, even in part, in a mental truth table, then what is the (typical) meaning by which the connective is understood?

First approximations to answers for questions (2) and (3) have already been hinted at above. Now I will begin the process of articulating proposed answers, so that we may arrive at the topic of the research reported herein. Three factors will be discussed—the most general meaning of IF/THEN, the form of the conditional sentence, and the presence of implicit propositions.

(i) The antecedent of a conditional sentence (usually the "if" clause) is "meaningfully related" to the consequent in that the antecedent states conditions which are relevant, though not necessarily crucial, to the value that the consequent has on at least one of a certain set of variables. Each value describes the status of the consequent on one standard on which the consequent is assessed. The standard of assessment concerns whether or not the consequent is true, correct or probable. When speaking referentially—that is, when assessing the referent of the consequent, one would determine whether or not the referent occurs, exists, or is likely to occur or exist. These standards are determined by the type of speech act which the consequent, or the entire sentence, is expressing. When the consequent is "asserted", the antecedent states conditions under which the consequent is more or less true, correct, probable, or etc. Conditional sentences such as the following will presumably require other standards of assessment:

"If you know what's good for you, you will be on the

next train."

"If at first you don't succeed, give up."

"If nothing comes up, I promise to be there."

The IF/THEN connective itself reveals nothing of the manner or modality in which the antecedent is allegedly relevant to the consequent—that is, whether the consequent must, or is enabled to, or is obliged to, or is permitted to, or is desired to, etc., be true(or correct or likely).

(ii) We have already encountered the fact that the alternative morphological forms of IF/THEN may have the effect of communicating slightly different meanings. The idea of "if" may presumably be conveyed by use of such expressions as "only if", "unless", "when", and "were". By the <u>form</u> of a conditional sentence, I mean something different from this. Conditional sentences, independent of their speech-act function, may possess the form of Subjunctive, Counterfactual, Future, and Ordinary conditional sentences: If p <u>were</u> the case, then q <u>would be</u> the case.(S) If p <u>had been</u> the case, then q <u>would have been</u> the case.(C) If p <u>is or should</u> be the case, then q <u>will</u> the case.(F) If p is the case, then q is the case.(O)

These various syntactic forms indicate different temporal relations which the antecedent and consequent events might have to the time at which the sentence is uttered or comprehended. Accompanying these temporal factors are contrasting presuppositions about the truth (or

correctness or probability) of the antecedent and consequent. For example, in a counterfactual conditional which is used assertively, the presupposition about the truth value of both the antecedent and the consequent is that they are FALSE, at the time of utterance or comprehension. Thus the two events purportedly referred to are hypothetical events. However, one could just as well hold that the expression "If p had been the case" means that p was not the case at some prior time.

(iii) I have already affirmed that persons comprehend conditional sentences in such a way that the antecedent(A) and the consequent(C) are related. This much is captured above in the general meaning attributed to IF/THEN. But more is needed. Two propositions (or the events which they purportedly designate) are never merely related simpliciter (that is, without the possibility rather they are always related of qualification), in some respects. Since everything is related simpliciter to everything else, there is no distinguishable relationship between two events unless they are related in some respects and not others. The general meaning of IF/THEN is not capable of including in it any or all of the specific respects. Yet IF/THEN may be understood to signal or invite the interpretation of relations between the antecedent and consequent. Any relation construed between the A and the C constiutes a proposition which is only implicit in the actual conditional sentence. These features of the meaning of IF/THEN can be

captured by the expression "CONDITIONALsub*k*(C,A)", which says that the consequent is conditional upon the antecedent, and that the respect or manner in which the *C* is conditional upon the *A* is some unspecified kind *k*. When IF/THEN is interpretated in this way, a person's understanding of a conditional sentence should consist of one or more propositions, of the above form, which relate two component propositions. The expression "CONDITIONALsub*k*" is thus a free predicate variable whose actual value would have to be supplied by the hearer as part and parcel of his construal of the conditional sentence.

Implicit Propositions

Now we are ready to briefly encounter another area of research, one which spans several disciplines. By looking upon the comprehension of conditional sentences as involving the construal of implicit propositions, we open ourselves to research concerned with the relations which bind together texts or discourse into a tolerably coherent sequence. Implicit propositions can be viewed as the "semantic glue" of a text (or discourse). No aspect of texts is more commonly acknowledged and less frequently investigated than the meaning which we "read between the lines." So far as psychological questions are concerned, the key to the study of text comprehension lies in discovering the variables which influence comprehension of the semantic glue--the

sources of the construal of implicit propositions. The boundaries of the category of implicit propositions are notorously porous. What is now regarded as implicit will one day be considered explicit, as our concept of the "meaning" of a sentence comes to allow for presuppositions and other propositions now viewed as outside of the standard meaning of a sentence. But this is just as it should be.

Most of the work currently relevant to the topic of implicit propositions derives from two areas of linguistic analysis. In recent years, formal linguists have been investigating several kinds of "presuppositions" which appear to be either essential or troublesome for the task of giving a complete analysis of sentence structure and meaning. A representative sample of these investigations are the following: Fillmore & Langendoen (1971), Karttunen (1970,1971), Kiparsky & Kiparsky (1971), Katz (1972), and Lakoff (1971). Though stimulating and important, there are two features of this reasearch which obviate its relevance for our purposes here. First, their concern with formal linguistic questions is orthogonal to a concern for discovering factors crucial in individual comprehension Second, the focus on isolated sentences largely ignores the factors influencing the coherence and the comprehension of texts and discourse. When an implicit proposition is discovered to be required for a formal semantic analysis of a sentence, this proposition must be accommodated in the

analysis by listing it as part of the meaning of one of the words in the sentence—typically the main verb.

It is in the discipline of theoretical poetics where issues of the coherence and interpretation of texts is attacked directly, though of course by many different schools of thought. (For a discussion of some of this work and further references, see van Dijk, 1972, Petoefi & Rieser, 1973, and Hirsch, 1967.) In the view of two writers in this area, (van Dijk and Bellert, 1970, 1973), the coherence of a text consists (stated loosely here) in the reoccurrence of propositions, either explicitly or implicitly, which have previously been stated or implicated in the text. Under this category of implicated propositions I am subsuming what they call presuppositions, implications, and probable consequences. From the point of view of the interpretor, they claim, a text is seldom coherent unless knowledge of appropriate extra-discourse information provides clues to the implicated propositions (van Dijk, p.101-103, Bellert, 1973, p.93-95). Especially important among the implicated propositions are those that involve purported <u>propositional attitudes</u> which the speaker has toward other propositions.

Conditional messages are a special case of texts, if conditional messages are not coherent independent of implicit propositions—those which the hearer must actively

determine and incorporate into his interpretation. For this reason, together with their manageability, IF/THEN sentences may be an ideal medium for getting one's methodological foot in the door of discourse structure and the comprehension of texts.

Some psychological research which bears on the semantic glue of discourse is that demonstrating the effect of knowledge of context on the ability of subjects to "make sense" of entire paragraphs. Many such demonstrations are presented by Bransford & Johnson (1973). In one class of their examples, paragraphs lacked coherence as a whole until subjects were given a word or drawing indicating the perceptual situation being described. The demonstrations in this class exemplify an extreme form of lexical or topic ambiguity. The subject's knowledge of the topic, here the perceptual situation, is ineffectual until the subject knows exactly which kind of situation is being described.

Another class of examples discussed by Bransford and Johnson reveal the effect of knowledge of the topic in producing alternate total interpretations of a text or in suggesting alternate connotative import for the very same sequence of events. A clear demonstration of this category of context effects involves the interpretation of John Donne's poem "A Valediction Forbidding Mourning." Hirsch (1967) reports naturalistic observations to the effect that

people approach the poem assuming, from the title, that it deals with attitudes toward death. This assumption attributes a genre to the poem, which is Hirsch's term for a concept which combines the general topic of the discourse with the type of overall message being conveyed by the text or with the global speech-act being performed by the speaker. When reading the poem, subjects' expectations that it deals with attitudes toward death are repeatedly confirmed by the text, even though death is nowhere explicitly referred to. For these reasons, subjects find it difficult to accept the alternate claim that the poem is about the parting of close friends. When this is assumed as the genre, expectations are likewise confirmed by the text, supporting at least as strongly the alternate interpretation. Subjects find it difficult to credence the second interpretation once they have experienced the first one. With this category of context effects we find that alternate genres or topics may enable the production of two contrasting, though equally coherent, interpretations of the same text.

STATEMENT OF THE PROBLEM

The global purpose of the present experiments is to demonstrate the presence, in persons' comprehension, of implicit propositions. The attempt to do this will employ

IF/THEN sentences, linguistic expressions which are not only intrinsically interesting, but which, on a small scale, appear to conveniently exhibit conceptual aspects shared by texts and discourse. Demonstrating the presence of implicit propositions amounts to showing that subjects are generally capable of reliably construing, during their comprehension of selected sentences, propositions about relations or events which are not explicitly brought out in the text.

These additional relations or events are those which constitute extra-linguistic matters, knowledge of which is generally thought to be factual beliefs rather than lexical definitions. Thus the term "implicit" means not stated in the standard linguistic meaning of the sentences in the text. Admittedly, no one really knows what is strictly stated by a particular sentence on a particular occasion. But, against the backdrop of present day psychological explanation of language comprehension, it is inexplicable that implicit propositions should constitute an integral part of a person's comprehension of a text.

At a somewhat more specific level, the purpose of the present research is that of discovering whether persons' comprehension of IF/THEN sentences may include propositions about any of 4 kinds of relations between the antecedent and consequent. These four kinds will be described below. Earlier I proposed an interpretation of the connective

IF/THEN, employing the symbolic expression "CONDITIONALsub$\underline{k}$ (C,A)." The free predicate variable CONDITIONALsub$\underline{k}$ was said to range over the respects in which the consequent proposition (or the event it describes) is understood to be conditional on the antecedent. The possible respects in which the STATUS of the antecedent is relevant to the STATUS (ie., the occurrence, truth, correctness, or whatever) of the consequent, I will call Modalities. Carrying the analysis further, I now want to propose that the meaning which a person construes for a subjunctive conditional sentence can be translated into a statement having the following form: "The STATUS $\underline{s}$ of $\underline{C}$ would be CONDITIONAL by MODALITIES $\underline{k}$ upon $\underline{A}$, were $\underline{A}$ to attain STATUS $\underline{s}$*", where $\underline{k}$ is a vector of predicates describing relations of $\underline{A}$ to $\underline{C}$, and $\underline{s}$ and $\underline{s}$* are values on such STATUS variables as truth, occurrence, probability, correctness, or etc. Corresponding expressions could be given for Ordinary, Counterfactual and Future conditional sentences.

There are many ways to classify possible relations between antecedents and consequents. The four Modalities which have been selected for the present experiments are far from constituting an exhaustive classification of these relations. (For the remainder of the paper I will be speaking referentially, wherever appropriate. Thus the expression '$\underline{A}$' will be used to designate the event purportedly described by the proposition $\underline{A}$, rather than

merely to name the proposition itself.) The names of the four Modalities are followed by a brief description and an example of each:

PHYSICAL CAUSATION: A directly influences C; "The tent will collapse during the night, if the wind gusts to over 30 mph."

CONVENTIONAL SANCTION: A makes C obligatory or permissable according to the rules; "Your bet would not have been accepted, if the race had already been under way."

MENTAL DECISION: A is the reason or the occasion for a decision which influences C; "If the meals were less expensive, there would be a long line at the airport restaurant."

ANALYTIC ENTAILMENT: A makes C logically necessary, assuming coreference, [because what C says is a paraphrase which is at least as general as A]. "Moisture in the wood overcomes the flames, if the rainsoaked logs extinguish the campfire."

If persons' construe conditional sentences to implicate relations between the antecedent and consequent, then when these sentences are presented as if they are contextually appropriate messages, subjects should be able to use their comprehension of the messages as a basis for further judgments. Specifically, subjects will be required to use their comprehension of messages in order to classify them into groups. The groups are defined by concepts

describing the four modalities. Classification type tasks (sorting and concept learning) are preferred here over memory tasks, because our interest is in the content of the context-appropriate construal of messages, rather than in what might be retained of, added to, or forgotten of the original interpretation. Memory tasks may introduce their own measurement bias (see Fillembaum, 1973, Ch.1).

If all persons were equal in competence for our tasks and if every subject exercised his abilities to the same degree, then differences in classification results among subjects for a particular Modality would nicely reflect differences in what was understood. Unfortunately, this utopia does not obtain. Therefore, what is required is a task with a conjoint ability-performance threshold. That is, the task should be one that is not solvable unless a critical level in the combination of ability and performance is manifested. A concept learning task with strongly constrained messages as instances of the concept seems to be just such a task. Although solution of a concept learning task depends on finding and using the relevant information, this type of task can ensure that solution is enabled by only the correct interpretation and utilization of the relevant stimulus information. With sentential messages as stimuli we encounter a problem not faced by traditional uses of concept learning and concept identification type tasks. The relevant attributes are "invisible", and subjects can no

more than be aimed in the direction of the attributes--they are embedded in the subject's construal of the message. The relevant variable of relation between antecedent and consequent contrasts sharply and importantly with such variables as shape, color, and number of borders.

The related paradigm of conjunctive concept formation has recently been used by Baker, Prideaux & Derwing (1973) in a similar context. In their study the relevant attributes, grammatical properties of the sentence, were likewise invisible in some sense, though each property possessed explicit surface "markings" in the sentences themselves. The subjects were able to learn to detect, for example, only such sentences which were passive in voice, interrogative in mood, and negative in value. Analysis of errors revealed differences in the difficulty or psychological salience of the attributes.

The focal empirical problem in the following experiments, to reiterate, is to discover the existence and detailed components of implicated content involving the 4 Modalities which have been described above.

GENERAL METHOD

The two experiments reported here are variations on a theme. The first study highlights the interpretation and classification of messages when the subject has previously learned the concepts underlying the classification scheme. In the second study the subject is required to discover or learn one of the concepts while he is classifying the messages. The most general question of concern in these tasks is whether college students are able to interpret the messages in such a way that their interpretations enable them to solve the tasks. From the perspective of students of "conceptual processes", the first task is similar to an attribute identification task, in which the subject "knows the rule". The second task is similar to a complete concept learning task, in which both the relevant attributes and the conceptual relations must be discovered. In both cases a reception paradigm is employed. For both tasks I assume that college students have some conceptual acquaintance with the attributes. However, the tasks contrast with concept learning tasks in that the so called attributes are relations between events described in the messages and, as such, the attributes are not detectable in the <u>sentences</u> but must be constructed during the subject's interpretation of

each message. In Experiment 1, the subject uses four concepts concurrently, classifying each message into one of four groups. Judging from pilot research, this task requirement appears to be considerably easier in most respects than that of discovering four concepts concurrently during the reading of potential instances. For this reason Experiment 2 has been restricted to one in which the subject is required to discover only one concept as he reads and classifies the messages.

Materials

The materials for both experiments consist of the same set of 96 messages typed on white 3 x 5 cards. The messages were constructed in accord with the following principles and constraints.

(1) Each message is constrained in what it says so as to express a relatively pure conditional Modality. The four Modalities, which I discussed earlier, are called Physical, Conventional, Mental, and Analytical.

(4) Each message has the form of one of four types of conditional sentence:

Ordinary IF/THEN (If A is the case, then C is the case);

Future IF/THEN (If A is the case, then C will be the case);

Subjunctive IF/THEN (If A were to be the case, then C

would be the case);

Counterfactual IF/THEN (If A had been the case, then C would have been the case).

(2) Each message is expressed in either normal or inverted order (If A, then C or C, if A), but not both

(3) Each message is about events in one of six possible contexts or circumstances: a factory in a small town, a camping trip to a national park, an airport terminal, a produce market on a downtown street, an afternoon at the horse races, and a kindergarten school.

In addition to these constitutive properties of the messages, several other constraints played a crucial role in the construction of the messages. Each clause in the IF/THEN messages has to describe a plausible aspect of one of the six contexts. With this restriction we avoid potential interference due to arbitrary or unmotivated clauses. In conjunction with this requirement, we also restrict any two messages from dealing with the same events. With respect to syntax, clauses have to be simple in structure, allowing clauses of the form NOUN PHRASE: VERB:NOUN/PREP PHRASE. However, infinitive, gerundive, and "that clause" complements, as well as relative clauses, are not allowed. (See Appendix C for the list of messages.)

Finally, and this is the crucial constraint, each message must belong clearly and predominantly to one of the

four conditional Modalities. This constraint demands, in the final analysis, that the events described by the two component clauses must be "closely related" in the world. That is, a physical, conventional, psychological, or logical factor which can be construed by the hearer as the factor responsible for the two events being related must be the predominant factor in this responsibility. After six months of constructing messages to meet these constraints, 96 initial messages had resulted. The initial stage of checking the semantic adequacy of the messages incorporated the responses of judges. Two graduate students in linguistics (under the assumption that here I would find speakers who were especially sensitive to nuances of semantic or communicative import) learned descriptions of the four types of conditional modality. The descriptions were similar to those presented in Appendix B. They were also allowed an "Other" category for messages which did not fit clearly into one of the four categories. On 19 of the messages there was a discrepancy between at least one of the judges and the a priori classification of the messages. By taking into account the direction of the judges discrepant classifications, these messages were modified to eliminate sources of confusion.

Secondly, the errors and explicit comments of pilot subjects greatly aided a finer tuning of the messages for the population of undergraduate students. Of course,

planned sources of superficial similarity were retained. Lexical feature commonalities between the clauses had to be prevented from being relevant to solution of the concept discovery task. The above discussed constraints insured that non-semantic perceivable aspects of the messages were not relevant to solution. Through these various procedures I managed to obtain a fairly reliable set of messages which are very difficult to distinguish and classify. The primary ordering of the 96 messages has been randomized subject to the following constraints. Each message in the presentation set is succeeded by a message differing from it as to context, modality, conditional form, and clause order The actual presentation sequence will vary for subjects in Experiment 1. Moreover, within each block of 16 messages, each value of each of the last three of these variables (modality, form, clause order) occurs as often as the alternative values. Only the six different contexts are not subject to this restriction.

EXPERIMENT 1

In this experiment subjects are asked to classify up to 96 messages into four categories. Each category is defined by a description of one of the four conditional Modalities. The subject reads all four descriptions and employs his interpretations of the descriptions as the

criteria for classification. A message fits appropriately into a category in virtue of describing two events which can be understood to be related in such a way that their relationship exemplifies one of the conditional modalities. A subject is considered to have performed in accord with the just stated standard of fit if he performs without a mistake for 16 successive trials. The dependent measures are the number of trials to criterion and the distribution of category classifications (and, hence, of errors in classification).

Subjects

Students in introductory psychology courses at the University of Alberta served as subjects. Fifteen subjects satisfactorily completed the task. Eight other subjects who undertook the task were replaced, for they were unable to satisfactorily complete it in 96 trials. The reasons for the disparities among individuals' performance, except for motivational lapses, is not known. Three of these eight subjects were exhibiting some progress toward solution by the last block of sixteen messages; the remainder had not improved over performance in the first sixteen trials.

Procedure

Each subject is acquainted with conditional sentences through the sentence 'If the cat's away, the mice will play'. He is told that the "if" clause serves to describe the antecedent event, while the second clause describes the consequent event. Before being given six examples of conditional messages, the subject is further told that there are many different ways in which the events described in IF/THEN messages can be related. Six classifications of such relations are named and are illustrated by the example messages. One of the examples is "If the vase were to break during shipment, then the company would repay us for the loss". The subject is queried only as to whether or not he is able to see differences between the relations exemplified in two of the example messages. If he replies NO, then he is asked to express to the experimenter one or more relations which he takes to hold between the two events in each of the two messages. The subject replies in this way until he "realizes" on his own initiative that there are differences in the relations exemplified in the two messages. He is not required to say what is the abstract nature of these differences, only to agree that there are differences.

During the instruction period each subject reads descriptions of the four conditional modalities. Concepts

of the four Modalities are called target concepts. (For the descriptions themselves, consult Appendix B.) The subject is then queried on the essential features of each concept and on a contrast of each concept with one other concept. The subject is allowed to view the descriptions while he formulates his reply to the query! The queries aid the E in bringing each subject to some minimal level of preparedness, so it is hoped. The E further stresses that each message, even if it describes an apparently unlikely pairing of events, should be considered as true or correct within its own idiosyncratic context.

When the subject confesses readiness to undertake the task, the E places the stack of message cards before the subject on the table. Displayed across the table in front of the subject are four 3 x 5 cards, one for each of the four categories of messages. On each of these cards is duplicated the description of one of the modalities which the subject has earlier read. These four target concept cards are in view of the subject throughout the experimental procedings. The subject begins by reading the first message and manually placing the card on the table below one of the four target descriptor cards. The E responds by saying "that's correct" or "that's not correct, and should be under concept X". Thus when the subject makes an error, he is corrected and he places the message under the proper concept. Subject and E continue in this manner until the

subject attains the performance criterion on all four of the target concepts.

Design

Each subject receives two repeated treatments. One consists of presentation messages of four types. These are symbolized with lower case letters: Physical (p), Conventional (c), Mental (m), and Analytic (a). Each subject also learns the four target concepts as criteria for classifying the messages into four groups. These target concepts are symbolized with capitals: P, C, M, and A. A simple between subject factor involves the order in which a subject encounters the messages. In order to avoid problems of effects due to message order, I attempted to determine whether the messages would be arbitrarily distributed as to difficulty or facilitory value within the sequence of 96 cards. Three intuitively meaningful starting points were selected. A subject either begins with card 1, card 33, or card 65 and proceeds through the stack from that point.

A problem with the design concerns the choice of the primary dependent measure. The number (or proportion) of classifications per category out of 24 messages per message type could be taken as the measure. Alternatively, I could use only the number (or proportion) of errors per response category. If the former route were chosen, the 4 x 4 matrix

of treatment response categories would contain correct responses in the main diagonal. Only a very small degree of success on the task would be sufficient to yield a significant interaction effect in the ANOVA. Any treatment main effects would be disguised by the presence of relatively larger values in the main diagonal. However, when the dependent measure is taken to be the number (or proportion) of errors per response category, the factor of message type is not completely crossed with the factor of target concept. There are only 12 error categories. One solution, using classifications as the measure, would involve a preliminary extraction of the sum of squares for one orthogonal comparison from the interaction sum of squares. The effect due to differences between correct and error classifications, diagonal versus off diagonal in the 4 x 4 matrix, could be removed in this way. Any main effect on error rate would remain disguised by this manuever, however. All in all it seems preferable to look at errors. The two treatments may be analyzed in separate ANOVAs. That is, the experiment may be viewed as two separate 3 x 4 factorial designs with order as one factor and either Message type or Target concept as the factor on which repeated measures are taken.

Results

The first dependent measure we will look at is the number of errors made during the task. An error occurred when the subject classified a message under an incorrect target concept. By grouping each subject's errors according to the message type (p,c,m,a) on which they were made, the experiment may be viewed as involving the two factors of Order (A) and Message type (B). Errors made to a message type give some indication of the ease of confusing messages of that type with messages of other types. The ANOVA revealed a significant main effect only for the treatment factor of Message type (for details consult Table 1A of Appendix A). The message types thus differed significantly as to their confusability or superficial similarity under subjects' interpretations. No differences were found for the 3 Orders in which subjects read the messages or for the interaction of Order with Message type.

Subjects' errors may be looked at in another way which is conceptually independent of the above scheme for grouping errors. Since each subject classified the messages under all four of the concepts, these may be viewed as another within subject treatment factor. Again the ANOVA yielded a significant difference only for the factor of Target concept (for details consult Table 2A of Appendix A). The four target concepts thus differed in the difficulty

which subjects encountered in recognizing messages that counted as instances of the four concepts.

The second dependent measure is the number of trials to reach criterion performance on each of the four target concepts. There being four targets, it is possible for the subject to reach critierion on each concept independently or on all four simultaniously. The overall mean for trials to criterion was 36.5. The ANOVA for this measure revealed a significant effect for the factor of Target concept (for details see Table 3A of Appendix A).

Some additional insight into the data may be garnered from the differences between treatment means for the analyses above. We can order the difficulty of the message types and the target concepts. These orderings may be useful for comparison with the results from Experiment 2. Table 1 displays the four means from each of the three analyses. For example, the second row, containing the entries 4.13, 1.4, 1.93, and 1.4, shows the mean number of errors on the target concepts P,C,N, and A. Several comparisons among means were made, using the convenient, though conservative, method of Sheffe, where it seemed that differences might exist. From Table 2a we see that the mean for message type m differs from the combined means for the remaining three types, just as the mean for c differs from the remaining three. Significantly more errors were made to

Table 1

TREATMENT MEANS FROM EXPERIMENT 1
FOR THE FOUR MESSAGE TYPES (pcma)
AND THE FOUR TARGET CONCEPTS (PCMA)

Measure:Treatment	p or P	c or C	m or M	a or A
ERRORS:Messages	2.13	1.13	3.40	2.13
ERRORS:Targets	4.13	1.40	1.93	1.40
TTC:Targets	46	26	44	30

Table 2

(a)

COMPARISONS ON MEANS FROM TABLE 1

	Comparisons				Category	p
ERRORS:Messages	1	1	−3	1	m:pca	.01
	1	−3	1	1	c:pma	.025
	1	0	−2	1	m:pa	.05 NS
	1	−2	0	1	c:pa	NS
ERRORS:Targets	1	0	−1	0	P:M	.01
	1	−1	1	−1	PM:CA	.01
TTC:Targets	1	−1	1	−1	PM:CA	.01

(b)

Difficulty Orderings Derived From Table 2a

ERRORS:Messages	m (pa) c
ERRORS:Targets	P M (CA)
TTC:Targets	(PM) (CA)

messages involving "mental decision", while fewer were made to those involving "conventional rules or regulations". This indicates that the m messages are readily confused with other messages, whereas the c messages are high in distinctiveness or ease of recognition. As for differences among the target concepts we see from Table 2a that the mean for P differs from its nearest neighbor M. The combined error means for P and M differ from the combined means for C and A. From the TTC means we obtain a similar though less informative picture. The combined trial means for P and M differ from the corresponding value for C and A. Only the error measure differentiates the concepts P and M. The orderings that result from these few comparisons are summarized in Table 2b. The type or concept which is low in distinctiveness or high in difficulty is on the left in each case. Parentheses enclose items which do not differ and are hence unordered.

We will now look at subjects' replies distributed into the 16 possible response categories combining p c m a and P C M A. The resulting 4 x 4 matrix appears in Table 3. It contains the proportion of messages of each message type which were classified under each of the 4 target concepts. In parentheses are the totals for each response category. The high proportion in the main diagonal indicates how readily messages of each type were recognized and classified under the correct modality. These modalities are thus valid

Table 3

PROPORTIONS AND (TOTALS) OF CORRECT AND ERROR YES REPLIES IN THE 16 RESPONSE CATEGORIES OF EXPERIMENT 1

		Targets P	C	M	A
Messages	p	.91 (328)	.02 (6)	.04 (13)	.04 (13)
	c	.02 (7)	.95 (343)	.02 (7)	.01 (3)
	m	.10 (37)	.03 (10)	.86 (309)	.01 (4)
	a	.05 (18)	.01 (5)	.03 (9)	.91 (328)

or real conceptual categories into which our subjects are able to classify messages, even though some subjects were not familiar with the categories as verbalizable concepts at the start of the experiment.

The errors which predominated suggest two illuminating qualifications to this statement. Note from Table 3 that only two of the 12 error categories contain more than one error per subject. Category mP holds well over one fourth of the total errors— those errors made by classifying a Mental decision message under the concept of Physical causation, as this concept was understood by the subjects. The idea of an event physically causing another event, rather than in some other manner, is a rather non-intuitive notion. Subjects may have initially looked only for the consequent event to have a physical event as one of its antecedents. It often took several errors before a subject realized that physical antecedent ≠ physical cause , and thus finally learned the original distinction between P and M. The second largest error category also occurred with concept P—category aP. Errors in mP were uncorrelated with errors in aP ($r = +.02$), suggesting an alternative source of confusion. Many of the a messages describe two physical events (or rather the same event described in two ways). Thus messages exemplifying physical causation are similar to a messages in that a pair of physical events or conditions is involved. Moreover, the relation between

events in both message types is a very close one, often appearing to be one of necessity. Yet if subjects had been continuously focusing on the meaning relations between clauses, aP errors would be very inlikely (remember that subjects had been instructed in the analytic relation involved in concept A). Rather we suggest that subjects are adopting a "referential attitude" towards the events described in the messages. Such an attitude, while essential for detecting events related by causation, rules, or mental decision, would account for the surprising difficulty of the a messages.

A final grouping of errors for which I will propose a source is that of the 29 errors made by incorrectly classifying messages under concept M. A salient feature of m messages is that they deal with the decisions and actions of people. I anticipated this to be a prominant source of confusion. To check for this possibility, I divided the non-m messages into two groups on the basis of one property--whether they explicitly mentioned persons or not. Out of 72 messages, 38 did and 34 did not. Errors were then classified into these two categories. Of the 29 errors made to concept M, 21 of these were to messages which explicitly mention people. Despite making errors of this sort, subjects did eventually become efficient at distinguishing messages which just happen to mention people from those messages in which people are involved crucially as mediating

agents whose decisions and actions precipitate the consequent event.

Discussion

It should be stressed that individual differences in Experiment 1 were quite large. The range in errors was 0-15, while in total trials to criterion it was 16-77. These differences occurred in spite of the fact that the four conditional modalities were explained to each subject and he read an example message for each concept. I suspect that the subjects differed in their comprehension of the instructions and explanations. That is, they were differentially prepared by the instructions to anticipate the complexity of the task. Assuming this to have happened, some subjects would not be prepared to interpret the messages to the depth of comprehension for which other subjects were prepared. Differences of this nature can be toned down only by selecting subjects from more lingui-conceptually homogeneous groups and by better instructional techniques.

The positive side of the results, to turn the coin, consists in the fact that subjects were able to reliably construe messages as exhibiting an invisible or implicit relation between the two events in each case. Alternatively speaking, subjects explicitly understood propositions which

were not explicitly expressed in the messages at all. (I don't mean to suggest, naively, that I or anyone else can look at a sentence and determine for every hearer what is explicitly expressed in that sentence.)

What these results may signify is as follows. Suppose for a moment that the following, captured in very large brush strokes, is what the subject does with most of the messages which he encounters during the task. He first construes a meaning for the message and then compares his interpretation against the four criteria, hoping to decide which concept the message falls under. Such a sequence of events would demand that the subject's interpretation already include information about a conditional relation holding between the two events. The subject thus has to decide whether this relation fits one of the concepts.

Alternatively, suppose that the subject does not construe the message unaffected by the four concepts which he has learned. Rather, by some entirely unknown process, the subject reads the message with one (or more) of the concepts ready in mind, attempting to construe the message so that its interpretation fits one (or more) of the concepts. That is, the subject attempts to force his interpretation into the mold of one (or more) anticipated conditional relation that could hold between the two events. The subject continues in this way until he construes an

interpretation which he takes to fit one of the concepts. (Before replying the subject could of course continue in the above manner, using the remaining concepts, in order to discover the best fit, but this does not alter the case at hand.) If this were descriptive of the subject's actual event sequence, one would again have to conclude that information about a conditional relation between events is part of the subject's interpretation. The difference in this case is that the interpretation is causally dependent on the instructional set of the subject. This is another form of context effect on comprehension, where the context is itself part of the internal cognitive environment, not of the perceivable surround.

Experiment 2 is concerned with recognizing and discovering a common conditional relation among a group of messages without knowing IN ADVANCE what the common aspect is. The instructional set for Experiment 2 does not include information about the target concept in question. The concept must be constructed by the subject out of whatever information he makes available.

EXPERIMENT 2

In the previous experiment subjects were taught four concepts and required to classify messages under categories

defined by these concepts. In Experiment 2 each subject is asked to discover or construct one of the four concepts and to recognize new instances of it. The subject begins with no knowledge of the paritcular concept which is assigned as his target concept. He is given no instances of the concept to serve as a criterion. The sources of information, available from the task environment, which the subject might utilize are three: (i) immediate feedback as to the correctness of each reply; (ii) interpretable similarity among the messages which turned up under the target concept; and (iii) the contrast between instances of the target concept and instances of other concepts. Additionally, the instructional set induced in the subject presumably includes information that the target concept dealt with some sort of retween the two events described in each IF/THEN message. Thus the subject is lead to adopt a "referential attitude" toward the received message.

Subjects

Subjects are again drawn from the pool of introductory psychology students at the University of Alberta. The data is from the 24 subjects who successfully completed the task. Six other subjects were rejected. Five of these six appeared, after 96 trials, no closer to solving the task problem than they were after 16 trials. The remaining subject did not venture to say YES often enough

for his progress to be evaluated. As it was necessary to restrict the task to 96 trials and confine it within 60 minutes, the data are from only those subjects who solved the task or who were evaluated as making progress after 96 trials. Errors from these subjects are the only errors which are potentially interpretable.

Procedure

During the instruction period the subject reads examples of conditional messages (just as in Experiment 1). Following this the subject is queried on three of the examples which are unrelated to his target concept. With each example he is first asked just to say what the two described events are. Next he is asked to report some of the relations between the two events. When such queries are satisfied for two of the examples, the subject is asked whether he feels the two events in one example are related in the same way as the two events in the second example. If he replies YES, the subject is further queried about similarities and differences until he can explain a difference between the two cases. If the subject replies NO, then he is asked to explain in what way they are different. This process was repeated with the third example. In this manner the E determined whether the subject could detect some differences or other regarding the relation between the antecedent and consequent events in

each case.

Following this the subject is told that he will encounter messages belonging to four different groups of which he is unaware. For each group the relation between antecedent and consequent will be somewhat different. His task is to recognize or detect those messages belonging to the target concept which he is trying to discover. In order to recognize these messages he has to discover what they have in common. At the beginning he is to read a message and say whether it belongs to his unknown target group. He will be corrected following each reply. Once he stumbles upon the first member of the target group, he is to use that message as a prototype in order to recognize the second message which is a member of the group. After seeing the second he will be able to use the combined information in order to recognize the third, and so on. He will continue in this fashion until he replies correctly to 16 messages in a row. He will then be asked to say what is common among all the messages in the target group —that is, what aspect of the relation between antecedent and consequent is manifested in each message.

When the subject professes readiness to undertake the task, four cards are placed before him on the table. Messages which belong to the target group are to accumulate under the card displaying "?". Messages belonging to the

remaining three groups will accumulate under three other cards and will be refered to collectively as the "leftovers". After the E replies "THAT'S CORRECT" or "THAT'S NOT CORRECT", he will tell the subject where to place the message card. As soon as these procedural details have been made clear to the subject, he is given the stack of 96 cards and told to begin by replying NO to each message until he is ready to conjecture that a message belongs to his target group. As he performs the task, the subject can watch the messages of all four groups accumulate in front of him. By this method the subject's memory is placed before him on the table. He is freed for discovering the target concept. The E sits at the end of the table and to the right of the subject, where the E records the subject's replies, informs him of their veracity, and directs the sorting of message cards into their designated columns. On completion the subject is asked to describe his target concept, as well as any commonalities he may have further noticed among one or more of the leftover groups.

Design

The primary dependent measure for this experiment is the number of YES replies to each of the four message types out of 24 replies per message type. The factor of Message type is again a repeated treatment. Additionally, each subject is arbitrarily assigned to one of four levels of the

Target concept factor (P C M A). As a result the error categories differ for each group of subjects. For a subject whose target is C, an error consists in placing a message from type p or m or a under the target concept card. The 4 x 4 matrix of YES replies (but not the YES errors) may be analyzed as a 4 x 4 factorial design with repeated measures on the second factor. A second dependent measure is the total trials to criterion performance on the target concept. Finally, success of each individual subject will be evaluated and compared by the following procedures. The absolute success of the subject in learning or discovering the target concept will be evaluated by both an objective and a verbal criterion. A subject who replies correctly 16 times in succession meets the objective criterion. A subject who can describe a concept which he has discovered in such a way that the description subsumes all members of the target group and distinguishes the concept from the three other concepts will satisfy the verbal criterion. Two statistical parameters of the YES reply data will be employed to guage the comparative success of the subjects. In conjunction with the two criteria, these parameters will enable multiple validation of the success of each subject's performance.

Results

The first item is the ANOVA for the 4 x 4 design with YES replies as the dependent measure. The fruits of this procedure are displayed in Table 4A of Appendix A. As expected the lone significant effect is due to the interaction of Target concept and Message type, indicating only that more YES replies were made to target (that is, correct) messages than to "leftover" messages. This relatively crude index of global success must be supplemented by information regarding the degree of correctness or appropriateness of each subject's performance. We want to know of each subject whether he acquired the concept of his target conditional modality while he was classifying messages. A more detailed parsing of the meaning of the above interaction effect is thus obtained by computing for each subject various measures of his degree of success in distinguishing instances from non-instances. Displayed in Table 4 are the results on four such indices of success, the chi-square statistic, the sensitivity parameter (d') from signal detectability theory, the objective criterion of task success (requiring the subject to reply 16 trials in succession without an error), and the verbal criterion (requiring the subject to describe his target concept in such a way as to subsume all of his target messages and distinguish the concept from the remaining unknown modality concepts.

Table 4

INDICES OF INDIVIDUAL SUCCESS IN EXPERIMENT 2

Target/ Subject	Chi-Square	d' First 48 trials	d' Second 48 trials	Objective Criterion	Verbal Criterion
PHYSICAL					
1	5.14	.56	.98		
2	21.56**	.34	5.63	OK	OK
3	25.17**	1.81	1.76		
4	23.58**	1.04	2.98	OK	OK
5	5.27	-.29	.82		
6	7.80*	.34	1.18		
CONVENTIONAL					
7	11.37**	1.07	.86		OK
8	3.94	.19	.55		
9	61.35**	2.90	7.40	OK	OK
10	10.38**	.57	2.24		
11	47.43**	1.81	7.40	OK	OK
12	3.41	.29	.77		
MENTAL					
13	9.50**	.67	1.44		
14	1.46	-.53	.98		
15	2.75	.40	.43		
16	6.00*	.76	.86		
17	50.33**	2.05	7.40	OK	OK
18	29.88**	.86	7.40	OK	OK
ANALYTIC					
19	38.80**	1.17	7.40	OK	OK
20	6.93*	-.07	1.22		OK
21	28.35**	1.48	2.60		OK
22	14.49**	.64	2.47	OK	OK
23	18.44**	.94	2.35	OK	OK
24	11.69**	-.38	7.40	OK	OK

*p<.05
**p<.01

The value of the chi-square statistic measures the degree of the subject's departure from random performance or from non-preference for saying YES among the four message types. Taken alone a significant value for chi-square could reflect a preference for classifying messages of an inappropriate type under one's target concept (such as classifying all p and m messages under target concept P). However, a departure in a direction away from correct performance would yield a negative value for the estimate of d'. The estimate of d' is computed for each subject from his proportion of correct YES replies and his proportion of incorrect YES replies (false alarms). The resulting value is a standardized index characterizing the subject's success in recognizing instances and ignoring non-instances of his target concept. Because the subject is learning the concept during the same period in which he is using his version of it to recognize instances, an overall d' for the 96 trials is somewhat misleading. An indication of both learning and successful performance is obtained by computing d' twice, once for the first 48 trials and again for the remaining 48 trials.

The final two indices, the objective and verbal criteria of success, provide an absolute, all or none partition of the subjects. The two statistical measure strongly confirm the judgment obtained from the absolute measures. Those subjects who met the objective and/or the

verbal criteria also were generally high on the two statistics. Several subjects who did not meet these criteria appear to have been close to learning the concept, judging from their significant chi-square and d' above 1.00 (subjects 3,6,10 and 13). Subjects 1,5,14 and 16 performed well during the second half, though probably for the wrong reasons, such as superficial similarities among instances. The remaining 8,12 and 15 were definitely unable to make progress in this task; perhaps they simply could not understand the instructions or profit by feedback.

Table 4 further reveals that concept A was considerably less difficult than the remaining three target concepts. This result was expected, for the modality of analytic entailment involves meaning relations between propositions, not relations between two events. Additionally, one should note that 10 subjects from other groups also met the verbal criterion for discovery of concept A, though they were not attempting to do so as part of their task. With more trials I might have found P, C, an M to be differentiated as to difficulty, but it is unlikely that subjects would have cooperated with further arbitrary impositions on their time and effort. The task turned out to be very demanding though, surprisingly, very enjoyable in spite of this in the eyes of almost all subjects.

As to the relative confusability of the four message

types, the results contrast with those of Experiment 1. Moreover, the types differ in confusability depending on the target concept of the subject. In Experiment 1 there were differences in error rate for both the Message type and Target concept factors. As the marginal error means in Table 5 show (the main diagonal has been ignored for this computation), only the errors means for Message type differ. The order of difficulty is p(mc)a, in contrast to m(pa)c for Experiment 1. The extremes are now anchored at p and a, indicating the relative high confusability of p messages and the high distinctiveness of a messages, across the four groups of subjects. The high confusability of the p messages, however, can be seen from Table 5 to be due predominantly to the excess of false YES replies made by subjects whose target concept was A, though A was the easiest concept overall. This high incidence of pA errors is complementary to the high incidence of aP errors in Experiment 1. Before a subject fully learned concept A, p messages would be more similar to a messages than would the other two types. Out of the 45 pA errors that did occur, 34 were committed during the first half of the experiment. Since both p and a messages exemplify a relation of "has to happen", I conjecture that subjects first recognized a vague relation of necessity in their target messages before they adequately distinguished between physical and logical necessity.

Table 5

TOTALS AND MEANS OF YES REPLIES IN EXPERIMENT 2

		Targets P	C	M	A	Error Means
Messages	p	85	27	33	45	5.88*
	c	26	92	31	21	4.39*
	m	36	33	86	15	4.66*
	a	21	14	23	100	3.22*
Means		4.66	4.11	4.83	4.50	

*Average of 18 subjects, main diagonal ignored

Target concept P also attracted a predominance of errors in one category, in this case category mP. Here, as in Experiment 1, m messages are confused with p messages and classified under concept P. Out of 36 such errors, 28 occurred during the first 48 trials. It appears that after initial confusion, the m messages then become the most contrastive with p messages. During the second 48 trials, more errors made were on c and a messages than on m messages. With this source of confusion overcome, subjects have learned enough to make more sophisticated errors, such as one would expect to occur when an element of "necessity" is recognized in some of the messages. From the subject's viewpoint, this "necessity" is best thought of as high subjective conditional probability, given knowledge by the subject of the antecedent conditions. Messages of type m are almost invariably construed as involving low probability pairings of antecedent and consequent events.

As I did for concept M in Experiment 1, I looked at the distribution of errors to those messages which either do or do not involve explicit mention of people. Out of 87 errors on M, 53 occurred to "people" messages. For the two subjects who quickly learned concept M, errors to "people" messages contributed 9 out of 10 of their errors. This result suggests an interpretation consistent with results from Experiment 1. When subjects begin to make progress in recognizing (saying YES to) m messages, they make errors

based predominantly on people involvement before isolating the distinctive character of the people involvement which is symptomatic of concept M.

Discussion and Conclusion

One of the questions to which this experiment was directed is whether subjects are able to interpret IF/THEN messages adequately for them to discover the concept for a Modality relation which is shared by a subset of the messages. The experimental problem and procedure was designed in such a way that it would be virtually impossible for a subject both to satisfy the Objective and Verbal criteria of success and to fail to discover the appropriate Modality. Recall that a Modality is a property which can be instantiated by a conditional message when a hearer construes a relationship, between the antecedent and consequent, which is an instance of that Modality. Other properties which such a relationship might manifest or instance concern, for example, the likelihood of the relationship and the temporal relations among the events. The rationale of the experiment involves the assumption that a person, in order to be able to discover the Modality shared by a subset of messages, must have in fact interpreted some of these messages so that an appropriate Modality is manifested by, or detectable in the relationship between antecedent and consequent. To put it crudely, a

person cannot discover a Modality which two messages share unless the Modality is manifested or detectable in his interpretation of each of the messages. Thus, the subjects who satisfied the Objective or/and the Verbal criteria must have interpreted their target messages so that the antecedent and consequent of each message were related by an implicit proposition manifesting one of the Modalities. Twelve of the subjects, in addition to their task requirement, actually also discovered the Modality concept which characterized a second subset of the messages.

What do the results of this experiment tell us about the way people interpret IF/THEN messages or about the meaning of the IF/THEN connective? Before turning to this question, I must first discuss the individual differences exhibited in subjects' performance of the task.

The large individual differences in success on this experiment appear to call into question the generality of the interpretative ability which the experiment served to demonstrate. Success on the task problem required considerable application of cognitive abilities in an effort to construct a concept adequate both to subsume a subset of messages and to distinguish these from other subsets. Because of task difficulty, which was indeed necessary for the type of inference that was anticipated, I can not presently rule out the possibility that the lack of success

by some subjects may be due to the absence of the requisite implicit propositions from their interpretions of the messages rather than to inefficient efforts at problem solving or insufficient conceptual complexity on the part of the subject.

The relevant implicit propositions may be so "implicit", that is, so taken for granted, that some persons have not yet acquired the facility for conceptual classification of such relationships. The presence of implicit propositions in one's interpretation of a message in no way requires or implies that one should also be able with ease to reflectively analyze and report on these propositions. In an effort to rule out the second set of inferences about individual differences, the analysis of subjects' errors is relevant. Consider several of the factors possibly influencing difficulty in learning the target concept.

The analysis indicates that errors made while discovering the concepts of PHYSICAL CAUSATION and ANALYTIC ENTAILMENT were often more "sophisticated" than those made to MENTAL DECISION and CONVENTIONAL SANCTION. The errors reflect the presence, in subjects' interpretations, of other relations between antecedent and consequent. Errors made to PHYSICAL CAUSATION indicate the presence of an undifferentiated "causality" relation. Errors to ANALYTIC

ENTAILMENT indicate that subjects were making judgments about the liklihood of the consequent, given the antecedent. No such inferences are possible for the remaining two concepts. With MENTAL DECISION the errors were more superficial in origin. Subjects were lead astray by fixation on the fact that people were consistently mentioned in the m messages; of course, people were mentioned in messages of the other three types as well. It is tempting to suppose that all of the unsuccessful subjects can and do include appropriate conditionality relations in their interpretation of IF/THEN messages, but were simply not able to focus on or to classify them. More sensitive (less difficult) tasks are required, however, in order to provide a convincing demonstration of this ability among the perhaps less astute problem-solvers. Two simpler tasks which use the same materials and which are expected to amplify the earlier results are the following.

A subject may be presented with several groups of 4 selected messages and told, for each group, to find the one whose meaning does not fit with that of the other three. The possible variables on which 3 of 4 messages would be similar while one differs are very few. Subjects choices are highly constrained and immediate explanations may allow the isolation of sources of difficulty. However, subjects may not be equipped to speak about conditionality relations between events or propositions. During pilot research

several subjects were asked to paraphrase some of the example messages in the instructions. They were not allowed to use the connectives 'if' or 'when' or 'whenever' in their paraphrase. The result was that subjects either sat in silence as if stunned by the lack of available alternatives or began to speak only to stop when they found themselves using the forbidden connectives. The experimenter then mentioned some alternative expressions from among the following: conditional upon, follows from, dependent upon, because, result of, causes, reason for, in virtue of, due to, bring about, influence, etc. Then and only then was a subject able to render a paraphrase of the message. The source of this peculiar silence may be gauged by the use of a probe-recall task. After the subject reads a series of messages, he may be given a noun phrase from either the antecedent or consequent of each message and asked to paraphrase (reconstruct) the messages. By this method it will also be possible to detect differences in expression for our four conditional Modalities. Relations involving rules and regulations may find expression in a consistent manner which also contrasts with the expression of logical necessity or direct causation. These or other more enlightened studies might amplify the reported results sufficiently to overcome any lingering doubts which may be gnawing at the more sceptical reader.

To return to our postponed question, let us consider

what is a Modality and how it could be that two events may be construed to have an appropriate Modality. I have earlier called the Modality of two events the manner or way in which some aspect of one event (or proposition) may be conditional on some aspect of the other. Further characterization of a Modality requires beefing up the above promissory variable called the "manner or way" in which two events are related. More specifically, a Modality can be understood as a kind of factor (circumstance, reason, disposition, condition, or whatever) which is responsible for the conditionality of one event on the other—that is, which enables or empowers the status of the antecedent to influence the occurrence (truth, probability, appropriateness, or etc.) of the consequent. The hearer's search for a Modality is, then, a search for the kind of factor whose existence might explain or account for one event being allegedly conditional on another.

Hence, evidence that a person can learn and even come to describe the Modality appropriate to a subset of messages, is a powerful argument for the following conclusion:

When construing meaning for an IF/THEN message, a person must typically utilize knowledge of events and of the Modalities of influence which the events would be capable of manifesting or be likely to manifest.

We have seen that subjects can construe appropriate

Modalities for IF/THEN messages. Now suppose it also to be true that persons are capable of recognizing certain pairings of events to be inappopriate, that is, unmotivated, artificial or incoherent. For example, assume that the second and third of these three sentences would violate expectations of coherence, if employed among our messages:

(i) If the produce were exposed to the sun, then it would ripen much too fast.

(ii) If the produce were exposed to the sun, then insurance would cover the kindergarten's liability.

(iii) If a child were injured during school, then it would ripen much too fast.

If persons are indeed capable of construing IF/THEN messages so that the antecedent and consequent are either interpreted as related by a Modality or as being inappropriately juxtaposed, then we know that the following must be true. As statements about any two arbitrary events may be paired as part of an IF/THEN message, virtually any aspect of a person's store of knowledge about events may be required to determine in what appropriate way, if any, one of the events could be conditional on the other. The implicit propositions which are derived from this store of knowledge are not only crucial for the coherence of a message, but also reveal to one a small portion of what the person "understands" in response to the message.

I am now ready to specify what the experimental results tell us, tentatively, about the cognitive meaning of IF/THEN messages. (1) First, the results are consistent with the opinion that, for purposes of communication, IF/THEN messages are supposed to consist of an antecedent and consequent which are "meaningfully related." This stricture on the interpreted meaning of IF/THEN messages is not a mere superficial concommitant or supplement to the real core meaning which the message should have, but rather is itself at the core. More specifically, it appears safe to say, in line with my earlier proposal (see STATEMENT OF THE PROBLEM above) regarding the meaning of the IF/THEN connective, that the use of 'IF/THEN' to connect two propositions has the semantic or communicative function of eliciting in the hearer an expectation that (briefly) the consequent C is CONDITIONAL by an appropriate Modality k on the antecedent A, where k is again a vector of predicates describing potential relations between A and C. It is then the option of the hearer whether he goes on to actually determine what is the appropriate Modality k—to judge whether the expected appropriateness is realized in a particular case. To do so he must retrieve information relevant to the possible Modalities of appropriateness for the events at hand. The connective IF/THEN itself merely serves to signal to the hearer that certain expectations on his part are in order. The active expectations can be said to monitor the coherence of the message.

(2) In what respects might or do hearers construe the antecedent and consequent events (or propositions) to be "meaningfully related?" Others have observed that subjects in logical reasoning tasks sometimes appear to be looking for a causal relation between the antecedent and consequent, or that they in fact gave IF/THEN sentences a "causal construal." In light of the results from the two experiments reported here, I can be much more specific regarding the relations which persons "look for" and which they are able to find. The four Modality concepts (PHYSICAL CAUSATION,CONVENTIONAL SANCTION, MENTAL DECISION, ANALYTIC ENTAILMENT) describe four of the respects or categories according to which relationships between two events (propositions) can be classified. As such these concepts serve to demarcate four kinds of implicit propositions, four types of semantic glue, by which subjects can and do impose coherence on the antecedent and consequent of an IF/THEN message. The exhibiting of these four Modalities reveals some of the richness of the cognitive meaning which people produce in the act of comprehending messages--richness which is not typically classified by semanticists (eg., Katz, 1972; Leech, 1969, 1974; Lyons, 1968) as part of the linguistic meaning of the sentence. Thus the method by which the Modalities were demonstrated is just one indirect procedure for empirically supplementing our inherently insubstantiable intuitions about the meaning which a

sentence ought to have when a person interprets it.

(3) The reader has perhaps noticed that construing an appropriate Modality for a message is analogous to making an explanatory inference. The act of determining that a particular message is coherent can be thought of as an act of inferring an existential hypothesis to the effect that there exists some factor which would be capable of enabling or empowering this antecedent to effect this consequent, or which is a reason why this antecedent could influence this consequent. From this analysis, a way of inducing a subject to search for explanatory information could be the following. Within some preordained context, present an IF/THEN message which the subject, on the basis of the relevant factual information that he possesses, is unable to construe to his own satisfaction an appropriate relation linking the antecedent and consequent. The subject would thus be made momentarily unable to infer or assume the existence of any factor or reason in virtue of which some aspect of the antecedent should be able to influence some aspect of the consequent. It may be useful to view language comprehension more generally as being a problem-solving situation to which the subject typically marshalls available interpretive resources so as to produce a contextually appropriate construal. Perhaps the hearer is often required also to search for more information before being able to bring coherence to the message or before pronouncing it to

be inappropriate.

A final remark concerns the differences in task difficulty induced by the four Modality concepts serving as target concepts. Recent findings by Tversky and Kahneman (Tversky & Kahneman, 1971, 1974; Kahneman & Tversky, 1973), regarding judgments about probability, is relevant to our earlier discussion of judgments about truth values and to our interpretaion of judgments about appropriateness or coherence. Consider the following results from Experiment 2 above. Concept A was significantly less difficult to discover than were any of the remaining three concepts. Messages falling under A (a messages) were confused most often with p messages and least often with m messages. During the second half of the task, p messages became most constrastive with m messages, averaging across subjects. I hypothesized that underlying these confusion errors there was a dimension of subjective conditional probability on which the various messages were seen as similar or contrastive.

The primary thesis of Tversky and Kahneman is that systematic "errors" in subjects' judgments about probability values and about comparative probability relations is due to a "representativeness heuristic." The judgments, made by naive as well as by professional judges, concerned the probability, for example, that object A belongs to class B,

that event A originates from process B, or that process B will generate event A. In making these judgments subjects take into account the degree to which A is representative of B (that is, similar to, appropriate to, or typical of B). Their analysis supports an alternative hypothesis about the comparative difficulty of the target concepts (or confusability of the four message types). The differences in difficulty may reflect the relative positions of the four Modalities of IF/THEN messages on the dimension Idiosyncratic-Representative. Judgments about representativeness may thus be another major kind of relation between antecedent and consequent, in addition to Modality relations, which subjects are capable of and are inclined to make. Knowledge about factual relations among events, whatever it consists in, must be such as to enable subjects to produce coherent or appropriate interpretations of IF/THEN messages and to rate a consequent as to its Idiosyncracy or Representativeness respective to the occurrence (or truth, etc.)

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APPENDIX A

Summary Tables for Analyses of Variance

Table 1

EXPERIMENT 1, ERROR DATA: ORDER(A) X MESSAGE TYPE(B)

Source	SS	df	MS	Error Term	F
Order (A)	0.7	2	0.35	S(A)	<1
S(A)	70.4	12	5.86		
Message (B)	38.8	3	12.93	S(A) X B	6.63**
A X B	9.3	6	1.55	S(A) X B	<1
S(A) X B	70.4	36	1.95		
Total	189.6	59			

** p<.01

Table 2

EXPERIMENT 1, ERROR DATA: ORDER(A) X TARGET(B)

Source	SS	df	MS	Error Term	F
Order (A)	0.7	2	0.35	S(A)	<1
S(A)	70.4	12	5.86		
Target (B)	78.0	3	26.00	S(A) X B	8.72**
A X B	35.3	6	5.88	S(A) X B	1.97
S(A) X B	107.2	36	2.98		
Total	189.6	59			

** p<.01

Table 3

EXPERIMENT 1, TTC DATA: ORDER(A) X TARGET(B)

Source	SS	df	MS	Error Term	F
Order (A)	563	2	281.5	S(A)	<1
S(A)	6554	12	446.2		
Target (B)	4487	3	1496.0	S(A) X B	7.18**
A X B	1938	6	323.0	S(A) X B	1.55
S(A) X B	7495	36	208.2		
Total	21037	59			

**p<.01

Table 4

EXPERIMENT 2, YES REPLY DATA: TARGET (A) X MESSAGE (B)

Source	SS	df	MS	Error Term	F
Target (A)	5.3	3	1.8	S(A)	<1
S(A)	212.46	20	10.6		
Message (B)	24.6	3	8.2	S(A) X B	<1
A X B	2167.9	9	240.9	S(A) X B	19.07**
S(A) X B	757.7	60	12.63		
Total	3168.0	95			

** p<.01

APPENDIX B

GROUP 1: The consequent event is dependent on a prior event because of physical conditions or events which directly cause the consequent event. (PHYSICAL CAUSATION)

GROUP 2: The consequent event is dependent on a prior event because of rules or regulations which stipulate (at least for the given context) that the consequent event SHOULD occur under certain conditions. These conditions importantly include the prior event. (CONVENTIONAL SANCTION)

GROUP 3: The consequent event is dependent on a prior event because the consequent is the outcome of voluntary action by one or more persons who take account of the prior event in choosing or opting to act. (MENTAL DECISION)

GROUP 4: The consequent event is dependent on the antecedent event because it is the very same event, but described in a slightly different manner. Hence, the statement should sound trivial or pointless.

From a logical point of view, the consequent clause is <u>logically (analytically) entailed</u> by the antecedent clause, assuming coreference. Thus one has "If <u>A</u>, then <u>A</u>." (ANALYTIC ENTAILMENT)

APPENDIX C

The 96 Messages Arranged According To Message Type

PHYSICAL CAUSATION

1. The factory would have flooded during the spring, if the town's snowfall had been heavier.

2. The temperature in the terminal has lowered considerably, if the air cooling system is working again.

3. If your suitcases had been fastened securely with straps, then they would not have burst open during handling.

4. The tent will collapse during the night, if the wind gusts to over 30 mph.

5. If electric power were knocked out, then operations would shift automatically to battery power.

6. If the mountain streams are flowing swiftly, then our canoes often capsize.

7. If the rain were to last for a long while, then our campsite would become a pool of mud.

8. The assembly line will screech persistently, if the equipment is low on lubrication.

9. One's view is frequently obscured by other fans, if the stands at the racetrack are crowded.

10. If the children use paint brushes during craft time, then the floor will be a mess by clean-up time.

11. A sick child transmits germs to the other children, if he or she attends kindergarten.

12. The market scales would have tipped, if your watermelon had weighed 25 pounds.

13. If the customers have been handling the tomatoes, then they will soon become soft.

14. If one were carrying metal objects, then they would activate the airport X-ray security equipment.

15. All the animals would have been frightened away, if

Lynn had chattered as usual.

16. If Susie had swung higher on the swing, then she would have injured her head.

17. The film projector would be knocked out, if a child were to trip over the cord.

18. If the jockey uses the whip at the right time, then his horse will run harder.

19. If the trainer had given drugs to my horse, then its performance level would have been increased.

20. If an appliance is assembled inadequately, then the control panel indicates the defective area.

21. Fruit and vegetables would spill onto the street, if a table leg were to collapse.

22. A loud drone will reverberate through the terminal, if a large jet touches down outside.

23. The horses would run much more swiftly, if the racetrack were hard and fast.

24. If the produce is exposed to the sun, then it ripens much too fast.

CONVENTIONAL SANCTION

25. If your boarding pass has not been signed by a ticket clerk, then the stewardess will not accept it.

26. If a passenger's luggage is overweight, then additional charges are added to his fare.

27. A defective item would be replaced on request from the buyer, if such an item were to originate at the factory.

28. Your bet would not have been accepted, if the race had already been under way.

29. A supervisor files a report on the accident, if a serious injury is sustained on the job.

30. The market will display a farmer's produce, if he obtains a sales permit from the city.

31. If a child were injured during school, then insurance would cover the kindergarten's liability.

32. The order of finish will be contested, if an official detects a foul during the race.

33. If you had purchased fruit at the farmers' market, then only cash would have been accepted in payment.

34. If your co-worker accumulates six months of unused sick leave, then he will receive extra vacation time.

35. If a person were to place a $2 bet, then he would receive an appropriately colored ticket.

36. If someone in the park is attacked by a bear, then neighboring sections will be closed to visitors.

37. If a horse leaves the gate too soon, then the race is started again.

38. You receive a 5% discount from the market, if you purchase over $20 of produce.

39. You would undergo a customs check, if you were arriving from a foreign country.

40. If an employee had arrived for work 30 minutes late, then $5 would have been docked from his/her pay.

41. Billie will get extra refreshments all next week, if he wins this week's drawing contest.

42. The park rangers would notify the RCMP, if they were to find the body of a missing camper.

43. The manufacturer would have replaced my canoe, if it had cracked during the trip.

44. If a ranger spots an illegal campfire in the park, then he informs headquarters of its location.

45. The flights would have been officially grounded, if visibility at the airport had been less than 1/2 mile.

46. A child misses out on the outdoor recreation period, if he starts a fight during indoor activities.

47. If a customer were to bring his dog into the market place, then the dog would be removed from the premises.

48. If your child had been under 2 and 1/2 years old, then she would not have been admitted into the school.

MENTAL DECISION

49. Most of the crowd would be jumping and screaming, if the race were a close one.

50. If the sand in the sandbox is wet, then Brad makes mud pies for the teacher.

51. Many of the children would hide from the teachers, if it were time for the afternoon nap.

52. If an interested parent visits the kindergarten, then children will invite him on a tour of the facilities.

53. If the mountain lion had come closer to our camera, then we would have taken his picture.

54. If someone tells a new joke on the job, then other workers will contribute jokes of their own.

55. Jason will switch to another airline, if his ticketed flight has poor connections.

56. Mrs. Dortmunder would have demonstrated a new game, if the children had been more attentive.

67. If the meals were less expensive, then there would be a long line at the airport restaurant.

58. The terminal fills with excited fans, if the hockey team is arriving home after a victory.

59. If you had left your overcoat on the plane, then someone would have turned it in to the airline.

60. We add some wood to the campfire, if one of us gets cold during the evening.

61. Customers would have bought more vegetables, if the vegetables had been cleaned before sale.

62. If a downpour were clearly imminent, then the farmers would move the produce inside.

63. If the employees' wages are not greatly improved, then production at the factory will come to a halt.

64. If I had brought more money, then I would have placed it all on SHOCKING PINK.

65. Potential customers stay away from the marketplace, if flies and gnats are there in abundance.

66. A spectator will destroy his worthless ticket, if his horse loses the race.

67. We will return to the campsite until tomorrow, if Jerry runs out of film before dark.

68. If the weatherman were to predict warmer temperatures, then I would leave the extra blankets behind.

69. If the farmers are giving away fruit, then children will flock to the market.

70. A friend would fill in for an absentee, if personal affairs were to cause his or her absence from work.

72. If an unexpected horse wins the featured race, then the jockey receives the praise for the victory.

ANALYTIC ENTAILMENT

73. Your suitcase may now be claimed, if your luggage is ready for pick-up.

74. If few fans place money on the races, then betting will be light for the day.

75. The cabbage would have been treated against pests, if the heads had been sprayed against insects.

76. If flight schedules have been altered, then the times of departures are different.

77. Moisture in the wood overcomes the flames, if rainsoaked logs extinguish the campfire.

78. The produce market would not be open on Sunday, if it were to be closed on weekends.

79. The factory's machinery no longer operates as it did, if its equipment is approaching obsolescence.

80. If a horse were to be disqualified from the race, then an entry would be barred from competition.

81. If the factory environment had been improved, then working conditions would have received an upgrading.

82. If a product is marked down from yesterday, then it costs less than it did previously.

83. The factory will turn out too many units, if production exceeds the monthly quota.

84. The track would have been in poor condition for racing, if the surface had been too wet to run on.

85. If the camping trip had lasted through Sunday, then the weekend would have been spent on recreation.

86. A passenger would be paged at the airport, if he or she were to be called over the terminal intercom.

87. One-half of the children would have been in attendance, if 50% of the enrollment had been absent.

88. If the children were to line up in single file, then they would stand one behind the other.

89. A fan's gamble has brought him money, if he has placed a winning bet.

90. A pair of girls' shoes will be missing at the school, if Linda loses her boots at kindergarten.

91. If the children are practicing pronunciation, then they are saying letters out loud.

92. If a customer buys the last of the apples, then the market's apples will be sold out.

93. The campers would run out of edible goods, if they were to exhaust the supplies of food.

94. If the passenger had made a reservation, then he would have arranged a seat in advance.

95. If an additional secretary were hired for the office, then the office work-force would increase by one.

96. If the two campers follow the wrong path back to the campsite, then they will lose their way in the forest.